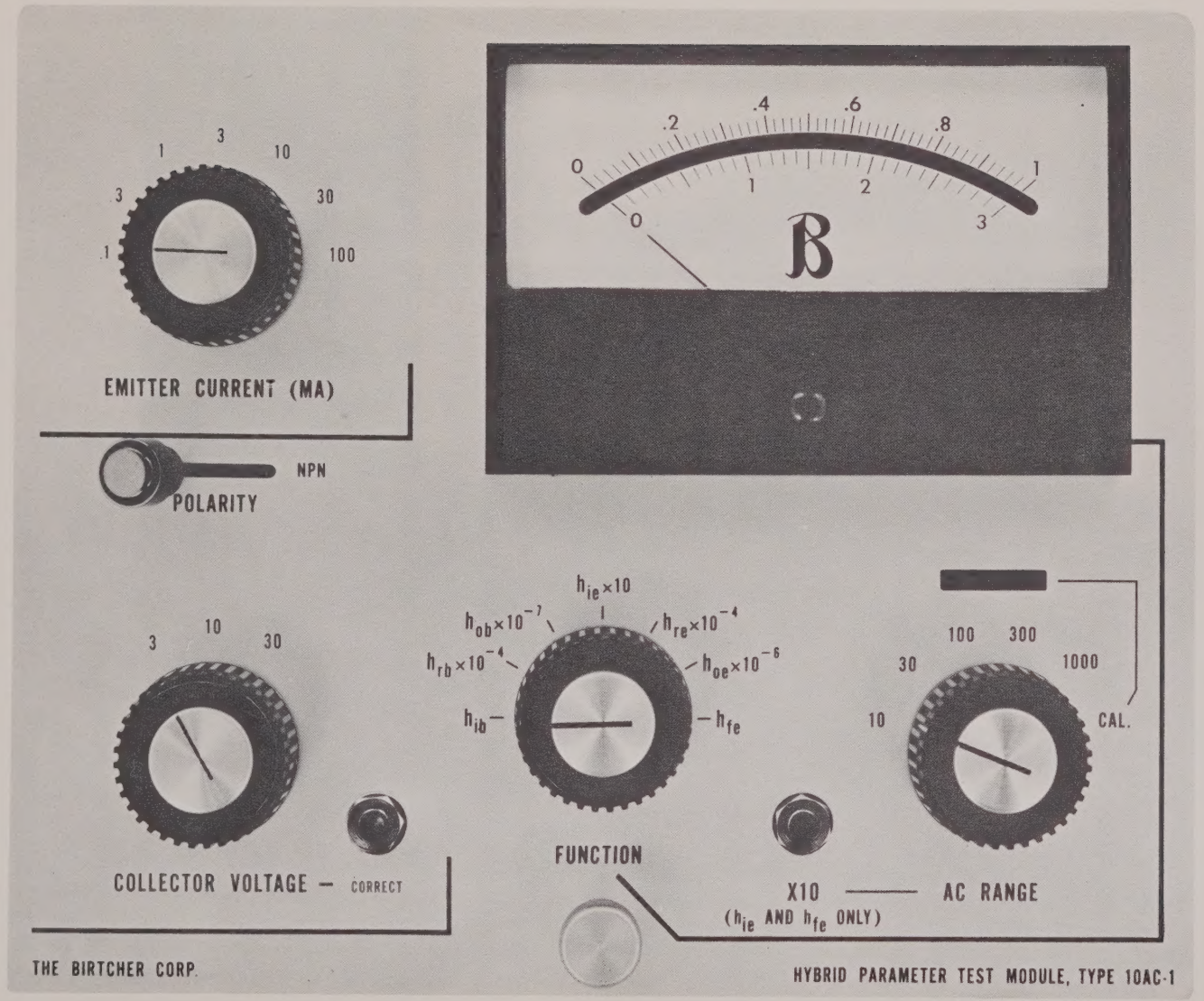
INSTRUCTION MANUAL

THE BIRTCHER CORPORATION INDUSTRIAL DIVISION
745 SOUTH MONTEREY PASS ROAD, MONTEREY PARK, CALIFORNIA

TYPE 10AC-1

TRANSISTOR HYBRID

PARAMETER TEST MODULE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β
1
3
10
30
100
.1
3
EMITTER CURRENT (MA)
NPN
POLARITY
3
10
30
COLLECTOR VOLTAGE —
CORRECT
$h_{ie}\times10$
$h_{ob}\times10^{-7}$
$h_{re}\times10^{-4}$
$h_{rb}\times10^{-4}$
$h_{oe}\times10^{-6}$
h_{ib}
h_{fe}
FUNCTION
100
300
30
1000
10
CAL.
X10
AC RANGE
(h_{ie} AND h_{fe} ONLY)
THE BIRTCHER CORP.
HYBRID PARAMETER TEST MODULE, TYPE 10AC-1

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SECTION 1

GENERAL DESCRIPTION

1.1 INTRODUCTION

The type 10AC-1 Transistor Hybrid Parameter Test Module provides the Birtcher Model 70 Semiconductor Test Set with the capability of making rapid direct measurements of small-signal hybrid parameters of transistors. The instrument is especially useful in an Engineering Laboratory or a Quality Control Department, or wherever quantitative measurements of transistor small-signal hybrid parameters must be made.

1.2 SPECIFICATION

A. PARAMETERS

Symbol	Description And Ranges Measured
h_{ib}	Small-signal input impedance, common base configuration, collector short-circuited for AC signal. 10, 30, 100, 300, 1000 ohms.
h_{rb}	Small-signal reverse feedback ratio, common-base configuration. $1x10^{-3}$, $3x10^{-3}$, $1x10^{-2}$, $3x10^{-2}$, $1x10^{-1}$.
h_{ob}	Small-signal output admittance, common-base configuration. $1x10^{-6}$, $3x10^{-6}$, $1x10^{-5}$, $3x10^{-5}$, $1x10^{-4}$, mhos.
h_{ie}	Small-signal input impedance, common-emitter configuration. 100, 300, 1000, 3000, 10,000, 30,000*, 100,000* ohms.
h_{re}	Small-signal reverse feedback ratio, common-emitter configuration. $1x10^{-3}$, $3x10^{-3}$, $1x10^{-2}$, $3x10^{-2}$, $1x10^{-1}$.
h_{oe}	Small-signal output admittance, common-emitter configuration. $1x10^{-5}$, $3x10^{-5}$, $1x10^{-4}$, $3x10^{-4}$, $1x10^{-3}$, mhos.
h_{fe}	Small-signal forward current transfer ratio, common-emitter configuration. 10, 30, 100, 300, 1000, 3000*, 10,000*.
	*Ranges available with X10 (h_{ie} AND h_{fe} ONLY) switch depressed.

1.2 SPECIFICATION (continued)

B. EMITTER CURRENT RANGES:

0.1, 0.3, 1, 3, 10, 30, 100 milliamperes.

C. COLLECTOR VOLTAGE:

3, 10, 30 volts.

D. ACCURACY: AC PARAMETERS:

AC Parameters: ± 3% of full scale;
DC voltages and currents: ± 2% of full scale.

E. CONSTRUCTION:

Aluminum alloy chassis. Anodized aluminum front panel with three-color silk screen markings.

F. WEIGHT:

8 lb., 5 oz.

G. DIMENSIONS:

8½ in. wide x 7 in. high x 13 in. deep.

SECTION 2

OPERATION

2.1 GENERAL

For ease and convenience of operation, the front panel of the Model 70 Semiconductor Test Set, including the Type 10AC-1 hybrid parameter test module, has been divided into three functional sections (figure 2-1).

To aid the operator in learning and remembering the basic operation of the instruments, different colors are used for the margins of each section. Black markings refer to emitter current controls and meter. Red markings refer to collector voltage controls and meter. Blue markings refer to hybrid measurement controls and meter.

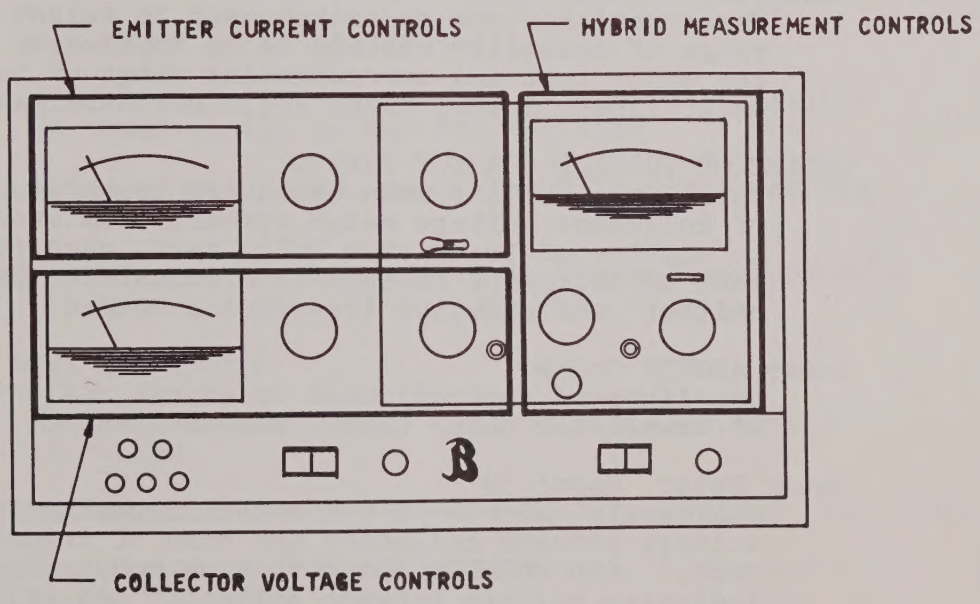


FIGURE 2-1

Front Panel Layout - Model 70 with 10AC-1 installed.

2.2 FUNCTION OF CONTROLS AND METERS

EMITTER CURRENT (MA) Range Switch
Seven-position rotary switch used to select desired range of emitter current to be applied to transistor under test and corresponding range of indicating meter (upper meter on Model 70 Semiconductor Test Set). Black markings.

2.2 FUNCTION OF CONTROLS AND METERS (continued)

Upper ADJUST Control
: Uncalibrated control used to adjust emitter current of transistor under test, within range selected by EMITTER CURRENT (MA) range switch on test module; current indicated on upper meter on test set. Black Markings.

Upper Meter, Model 70
: Dual-scale, mirror-backed meter; indicates emitter current of transistor under test. Ranges are selected by EMITTER CURRENT Range Switch.

POLARITY Switch
: Two-position lever switch used to provide proper power supply and meter polarity for testing PNP or NPN transistors. Black Markings.

COLLECTOR VOLTAGE Range Switch
: Three-position rotary switch used to select desired range of collector voltage to be applied to transistor under test and corresponding range of indicating meter (lower meter, Model 70). Red Markings.

COLLECTOR VOLTAGE-CORRECT Switch
: Pushbutton switch; when depressed transfers low side of collector voltage meter circuit from ground (base) to emitter of transistor under test; used for adjustment of collector voltage with transistor in common emitter configuration (base not grounded). Red Markings.

Lower ADJUST Control
: Uncalibrated control; used to adjust collector voltage of transistor under test. Red Markings.

Lower Meter, Model 70
: Dual-scale, mirror-backed meter; normally indicates voltage between collector and base of transistor under test; with CORRECT pushbutton on module depressed, indicates voltage between collector and emitter of transistor under test; Ranges are selected by COLLECTOR VOLTAGE Range switch.

FUNCTION Switch
: Seven-position rotary switch used to select transistor hybrid parameter to be measured. Blue Markings.

AC Range Switch
: Six-position switch used to select range of transistor hybrid parameter indicated on test module meter; also provides a calibrate position for adjustment of oscillator level. Blue Markings.

2.2 FUNCTION OF CONTROLS AND METERS (continued)

X10 (h_{ie} and h_{fe} ONLY) Switch
Pushbutton switch; when depressed reduces AC signal to base of transistor by a factor 10, multiplying the h_{ie} and h_{fe} readings by a factor of 10.

AC Meter
Dual scale, mirror-backed meter; indicates hybrid parameter selected by FUNCTION switch; Ranges are selected by AC RANGE Switch and by X10 (h_{ie} and h_{fe} ONLY) switch, if depressed.

Calibrate Control
Potentiometer for adjustment of oscillator level when AC RANGE switch is positioned to CAL.

2.3 INITIAL TURN ON AND WARM-UP

1. Turn both ADJUST controls fully counter-clockwise.

2. Put POWER switch in ON position.

3. After a warm-up period of 1 to 2 minutes, switch AC RANGE switch to the CAL position.

4. Adjust the CAL adjustment for full scale reading on the AC meter.

NOTE: This calibration should be checked periodically while in use.

2.4 DC BIAS ADJUSTMENT

1. Set POLARITY switch to type of semiconductor to be tested.

2. Set EMITTER CURRENT RANGE switch to desired test range.

3. Set COLLECTOR VOLTAGE RANGE switch to desired test range.

4. Depress TEST switch.

5. Turn LOWER ADJUST control until desired collector voltage is indicated on voltage meter (lower left).

6. Turn UPPER ADJUSTMENT control until desired emitter current is indicated on EMITTER CURRENT meter, (upper left).

NOTE: Voltage is normally read between collector and ground (base). For V_{CE} reading depress the VOLTAGE CORRECT pushbutton. Do NOT make hybrid measurements with this button depressed.

2.5 HYBRID PARAMETER MEASUREMENTS

1. Set FUNCTION switch to hybrid parameter to be measured.

2. Turn AC METER RANGE switch to lowest range that allows full scale readings.

3. Read hybrid parameter values directly on AC meter. Parameter values are multiplied by factors indicated on FUNCTION switch. On h_{ie} and h_{fe} measurements depressing X10 button, multiplies values by an additional factor of 10. For all measurements except h_{fe}, use correction graph (figure 2-2) for correction factor when AC RANGE switch is in 300 and 1000 positions.

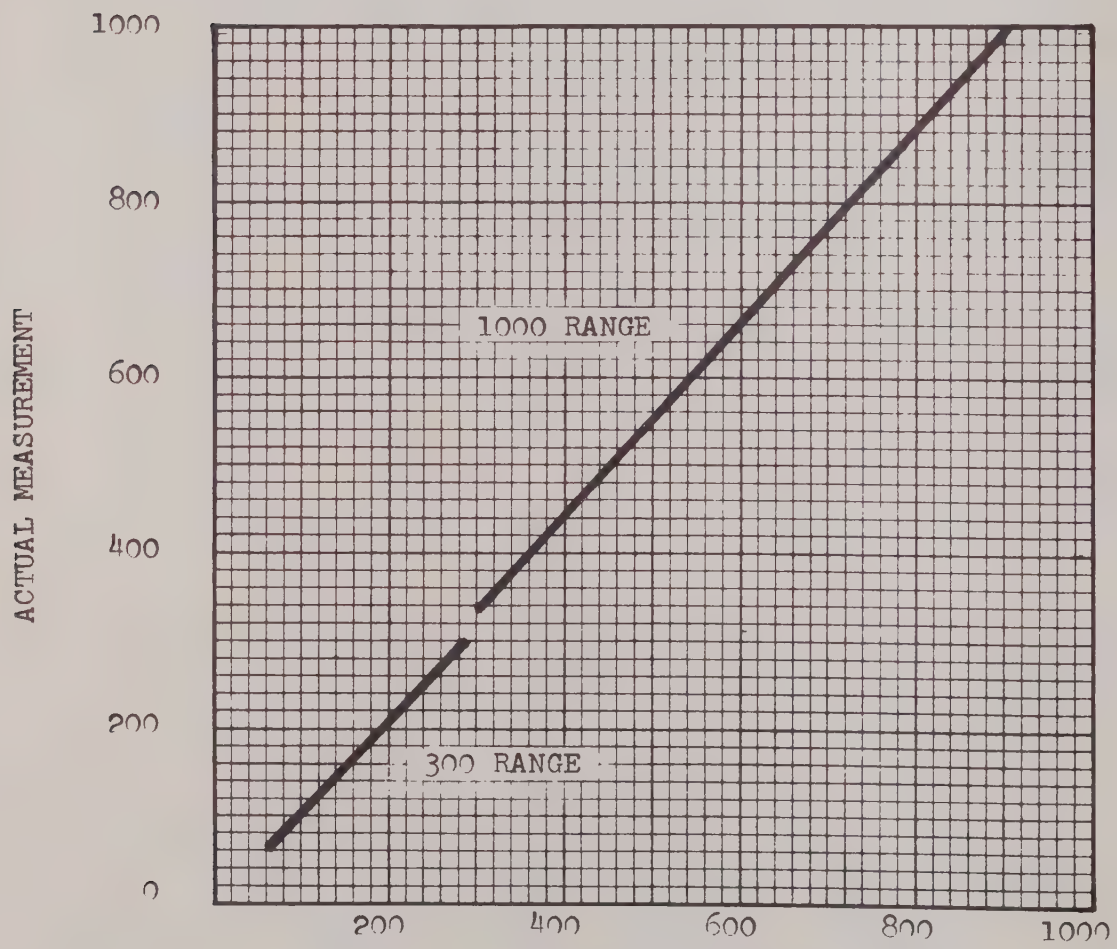


FIGURE 2-2

AC METER CORRECTION GRAPH

TYPE 10AC-1 TEST MODULE

SECTION 3
THEORY OF OPERATION

3.1 MEASUREMENT OF h_{ib}

h_{ib} is defined as the AC input impedance in ohms with the output AC Short Circuited and the transistor connected in the common base configuration.

h_{ib} is measured by feeding a constant current of 100 ua (derived from a 10K resistor in series with 1 volt source) into the transistor input and measuring input voltage, (figure 3-1). The AC signal is prevented from flowing into the emitter current supply by the high impedance of parallel-resonant circuit L204-C230. The 10 ohm resistor in the collector circuit is so small that the collector can be considered shorted to ground.

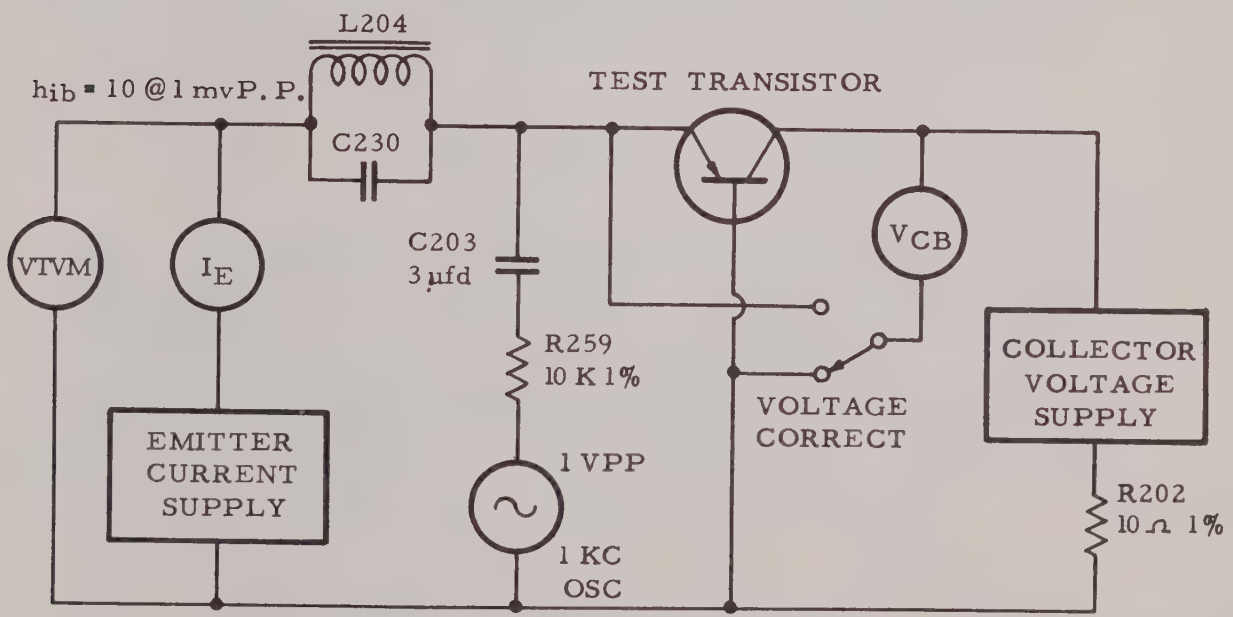


Figure 3-1 h_{ib} TEST CIRCUIT

3.2 MEASUREMENT OF h_{rb}

h_{rb} is defined as the reverse voltage transfer ratio with the input AC open circuited and the transistor connected in the common base configuration.

A value for h_{rb} is determined by applying a constant AC voltage to the collector and measuring the voltage appearing at the emitter (figure 3-2). The AC signal is prevented from flowing into the emitter current supply by the high impedance of the parallel resonant circuit L204 - C230.

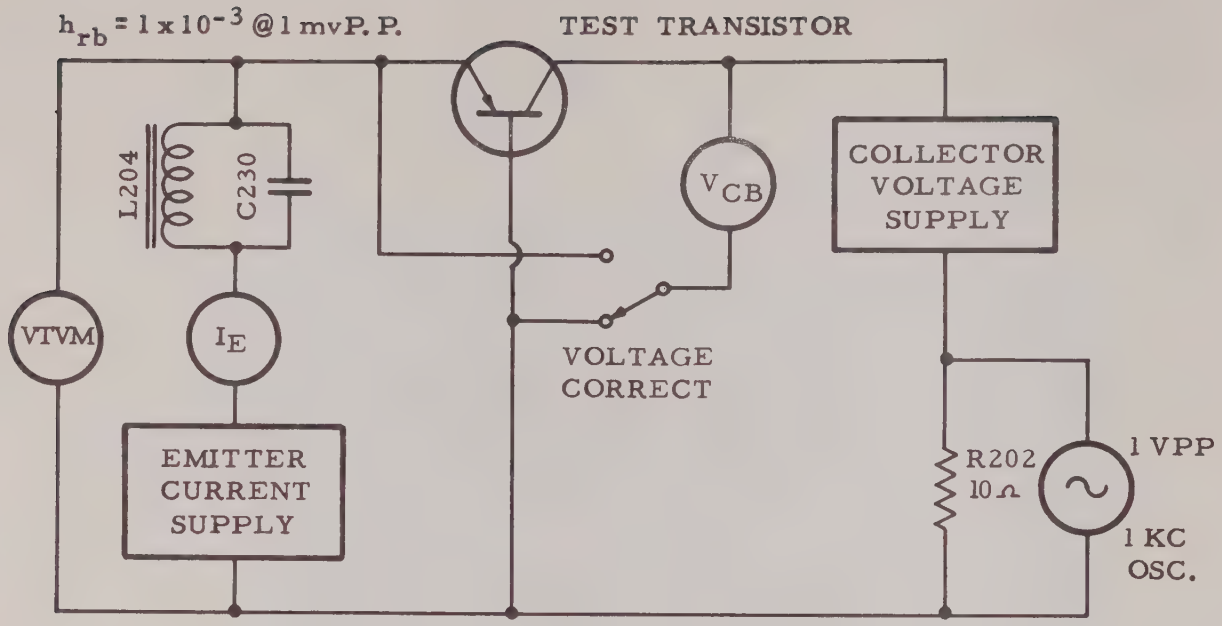


Figure 3 - 2 h_{rb} TEST CIRCUIT

3.3 MEASUREMENT OF h_{ob}

h_{ob} is defined as the output admittance (in mhos) with the input AC open circuited, and the transistor connected in the common base configuration. h_{ob} is derived by measuring the current flowing through the transistor when a constant voltage is applied to the collector (figure 3-3). The greater the admittance the less the impedance, and the greater the AC current. This current is measured by the voltage developed across a 1K resistance between base and ground. A resonant circuit shunts this resistor with an impedance much greater than 1000 ohms. (Its DC resistance is about 100 ohms).

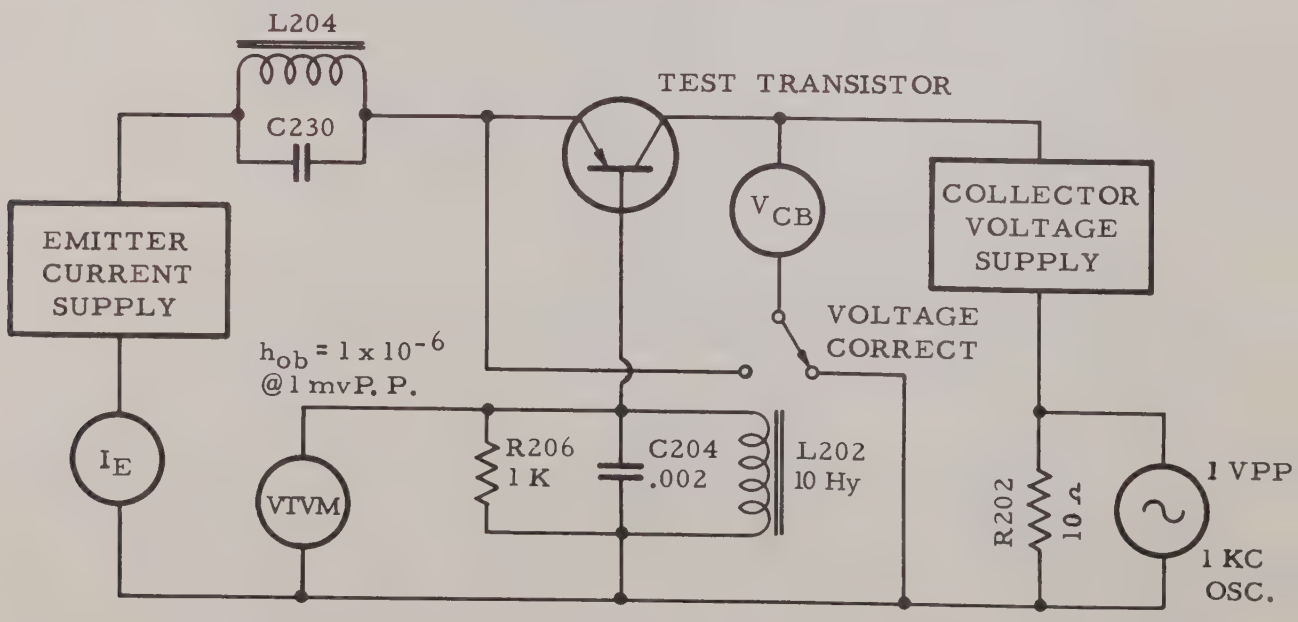


Figure 3 - 3 h_{ob} TEST CIRCUIT

3.4 MEASUREMENT OF h_{ie}

h_{ie} is defined as the AC input impedance, in ohms, with the output AC short circuited and the transistor connected in the common emitter configuration.

This is measured by feeding a constant current into the transistor input and measuring input voltage (figure 3-4). The emitter is AC short circuited to ground by C231. The AC signal is prevented from flowing to ground by the high impedance of parallel resonant circuit C204 and L202.

To accommodate testing of transistors with high DC h_{fe} at low currents, the AC input signal can be reduced by a factor of 10. This is accomplished with the h_{ie}, h_{fe}, X10 pushbutton; when depressed, the switch removes the short circuit across resistor R261, increasing the resistance in series with the oscillator from 100K to 1 meg ohm, thus reducing the base signal from 10 to 1.

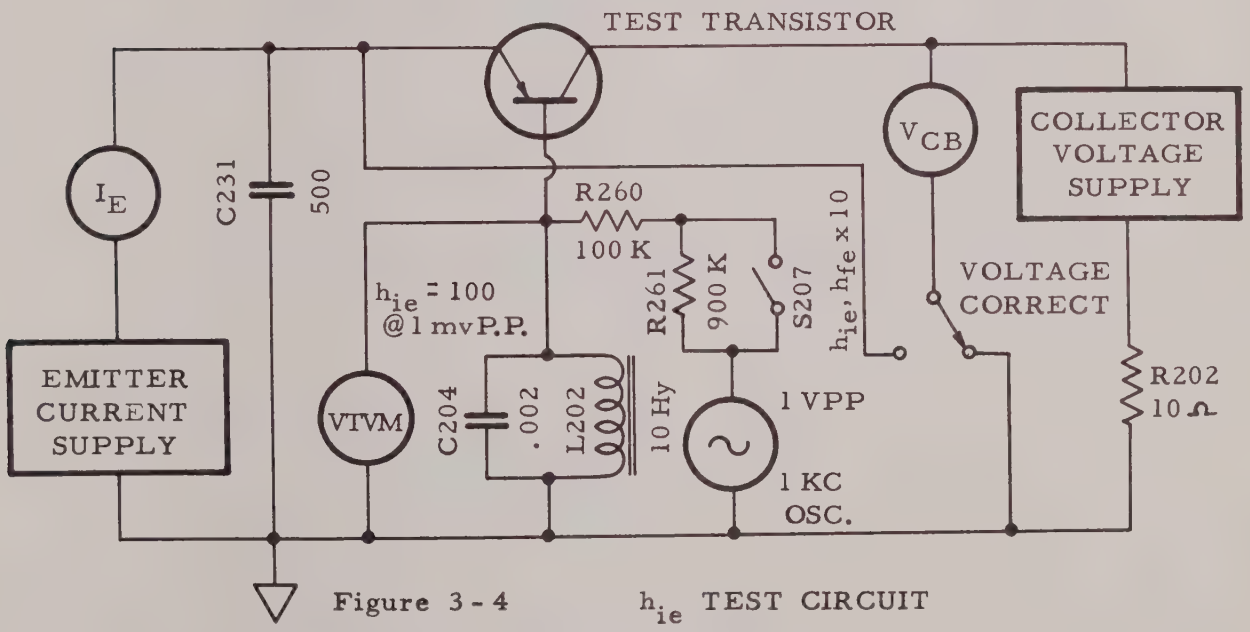


Figure 3-4 h_{ie} TEST CIRCUIT

3.5 MEASUREMENT OF h_{re}

h_{re} is defined as the reverse voltage transfer ratio with the input AC open circuited and the transistor connected in the common emitter configuration.

The test circuit (figure 3-5) is similar to that used for the measurement of h_{rb} but with the difference that for h_{re} the VTVM is connected to the base instead of the emitter.

The emitter is AC short circuited to ground by C231. The AC signal on the base is prevented from flowing to ground by the high impedance of parallel resonant circuit C204 and L202.

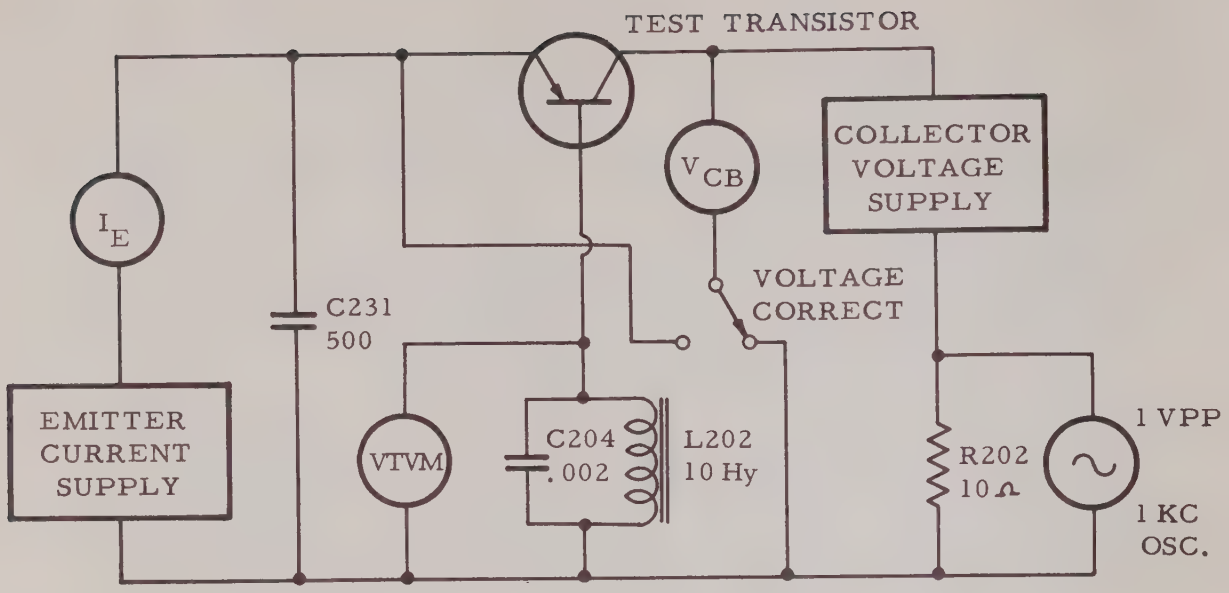


Figure 3-5 h_{re} TEST CIRCUIT

3.6 MEASUREMENT OF h_{oe}

h_{oe} is defined as the output admittance (in mhos) with the input AC open circuited, and the transistor connected in the common emitter configuration.

The test circuit (figure 3-6) is similar to that used for h_{ob} except the current flowing through the emitter is measured by the voltage developed across a 100 ohm resistance between the emitter and ground.

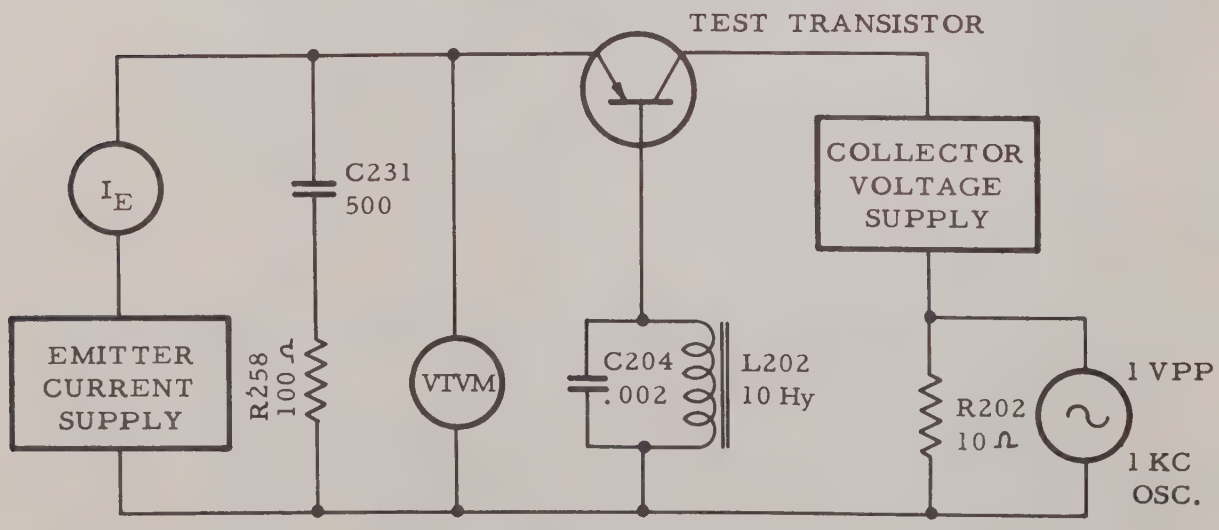


Figure 3-6 h_{oe} TEST CIRCUIT

3.7 MEASUREMENT OF h_{fe}

h_{fe} is defined as the AC forward current transfer ratio, with the output AC short circuited and the transistor connected in the common emitter configuration.

h_{fe} is measured by applying a constant current AC signal to the base and measuring the voltage (thus current) developed across a 10 ohm resistor in series with the collector.

DC Base current is bypassed to ground by resonant circuit L 202 and C 204. The emitter is AC short circuited to ground by capacitor C231. The 10 ohm resistor in the collector circuit is so small that the collector may be considered shorted to ground.

As with the h_{ie} test, the AC input signal to the base can be reduced to accommodate testing of transistors with high DC hFE at low currents. This is with the X10 (h_{ie}, h_{fe} ONLY) push-button; when depressed, the switch removes the short circuit across resistor R261, increasing the resistance in series with the oscillator from 100 K to 1 meg., thus reducing the base signal from 10 ua to 1 μa.

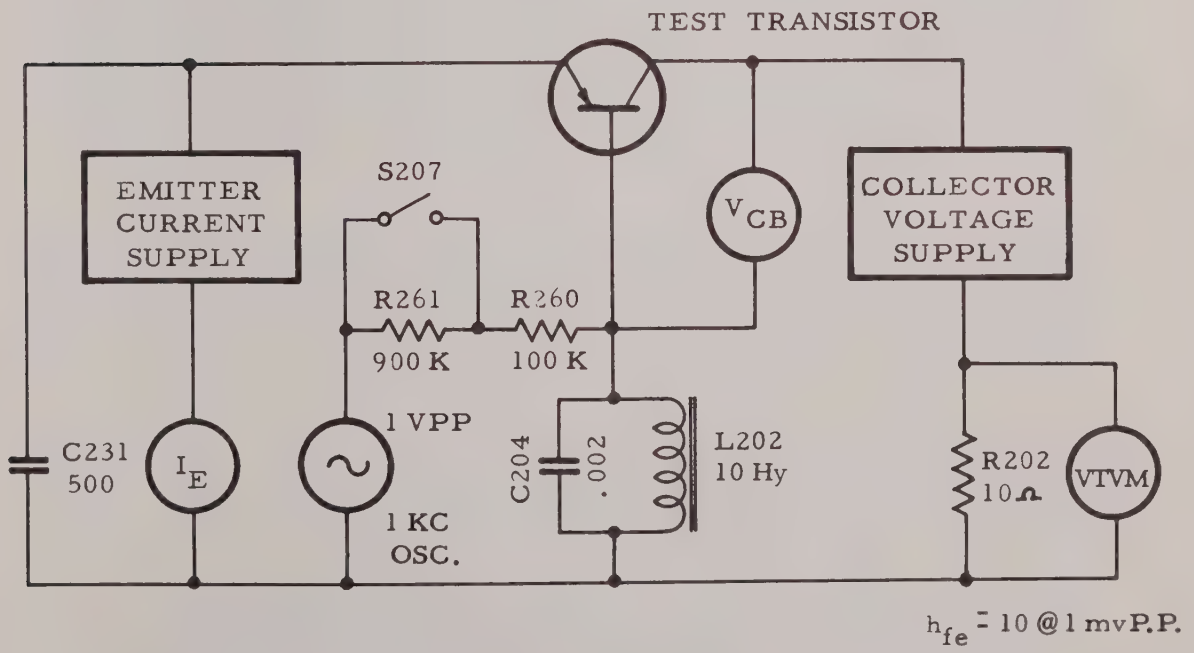


Figure 3-7 h_{fe} TEST CIRCUIT

SECTION 4
CIRCUIT DESCRIPTION

4.1 EMITTER CURRENT SUPPLY

The emitter current supply provides variable current to the emitter of the transistor under test.

DC for the emitter current is supplied by transformer T102: Secondary winding (terminals 3, 4 and 5) is full wave rectified by diodes D103 - D104 and filtered by C103. Part of the DC supply voltage is applied across variable resistor R103 (upper ADJUST control). The voltage developed on the wiper of R103 is filtered by R216 and C207 and applied to the base of emitter follower transistor Q201 in series with the output of the DC Supply. Secondary winding (terminals 7 and 8) is half wave rectified by D205 and filtered by C205; Voltage developed in this circuit is used to provide forward bias to Q201.

Polarity of the output is switched by S205 Polarity. A set of contacts on relay K201 is in series with the ungrounded output of the current supply. Output voltage from K101 is connected to a section of S202 (EMITTER CURRENT Range switch). This section of S202 connects a resistor (R218 through R223) in series with the emitter current supply, thus limiting the available current to the maximum value indicated by the position of the switch. On the highest current range, 100 milliamperes, no resistor is used, the current being limited by the DC resistance of inductor L203.

Current metering is provided by M102 (upper meter, Model 70). Current shunt resistors R225 thru R231 are selected by another check on S202. Another set of contacts on S205 switch polarity of input signal to M102. The current is supplied to the transistor being tested through resonant circuit L203 and C230, the function of which is discussed in section 3.

4.2 COLLECTOR VOLTAGE SUPPLY

The collector voltage supply provides variable voltage to the collector of the transistor under test.

Variable transformer T104 (Voltage ADJUST) supplies 60 cycle AC to the primary of T103. Secondary windings on T103 are selected by S203 for proper voltage output. Voltage selected by S203 is full wave rectified by diodes D201 thru D204 and filtered by capacitors C201, C202 and choke L201. The voltage drop across L201 is used as the signal for the protection circuit.

4.2 COLLECTOR VOLTAGE SUPPLY (continued)

One side of the DC output voltage is connected through POLARITY switch S205 to the collector of the transistor being tested. The other side of the collector voltage is applied through a set of contacts on relay K201 and through S205 to FUNCTION switch S201. A 10-ohm resistor, R202 is connected from the low diode of the collector voltage source to ground to provide an impedance across which oscillator output or vacuum tube voltmeter input may be connected for various measurements.

The collector side of the output from the collector voltage source is connected through a portion of one section of POLARITY switch S205 to one side of collector voltage meter M101 (lower meter). The other side of M101 is returned through another set of contacts on S205 to section B COLLECTOR VOLTAGE Range selector switch S203. Section B of S203 connects a multiplying resistor, R214, R243, R212, in series meter corresponding to the collector voltage selected (3, 10, or 30 volts). The resistor selected by S203B is returned to ground through normally closed contacts on CORRECT switch S206.

Meter M101 then indicates the voltage between the collector of the transistor being tested and ground (base). However, when S206 is depressed, contacts on this switch transfer the low side of the selected multiplying resistor to the emitter of the transistor being tested. Under these conditions, M101 indicates V_{CE}, the DC voltage between the collector and emitter of the transistor being tested. CORRECT switch S206 is depressed only when a transistor is being tested in the common-emitter configuration.

4.3 PROTECTION CIRCUIT

The protection circuit is used to protect the collector voltage supply against over-currents that may result from testing shorted transistors.

The protection circuit consists essentially of two sections: The protection circuit (including the sensing and control portions of the overall protection circuit), and the power control relay, K201. Under normal conditions, overload relay K101 remains de-energized whenever TEST-RESET switch S102 is operated to TEST. The contacts on K101 complete the circuit from the DC output voltage of rectifiers D101 and D102 to the coil of relay K201, energizing this relay. With K201 energized, both the emitter current supply and collector voltage supply circuits are completed, providing operating voltages to the transistor being tested.

4.3 PROTECTION CIRCUIT (continued)

If an overload should occur, the DC voltage drop across L201 will rise. When this voltage exceeds approx. 4 volts Q102 goes into a negative resistance state, discharging C102 through the gate of the controlled rectifier Q101. This triggers Q101 into a conducting state, energizing K101 and causing overload indicator S102 to come on. When K101 is energized, its contacts open and remove power from the coil of K201, opening the contacts of this relay and thus removing potentials from the transistor being tested.

When the overload condition is corrected, S102 must momentarily be opened (operated to RESET) then again closed (operated to TEST) to restore normal operation.

4.4 1000 CYCLE OSCILLATOR

The 1000 cycle oscillator is used to generate the input signal for measurement of the hybrid parameters. The 1-kc signal is generated by phase-shift oscillator V202, the pentode section of a type 6U8A tube. Feedback from plate to grid is provided by phase-shift network C209, R234, C210, R235, C211, and R236 which, with the 180-degree phase shift through the tube, makes the feedback signal in phase with the original signal on the grid, thereby generating and sustaining oscillation. The proper phase shift to maintain oscillation occurs essentially only at a frequency of 1-kc thus causing the output from this section to be very nearly a pure sine wave.

The output from the plate of V202A is coupled to the grid of amplifier V202B (the triode section of V202) through Capacitor C214 and a voltage divider consisting of resistor R213 and variable resistor R245.

Variable resistor R245 is the calibrate control which is used to adjust the input to V202B so a standardized 1-kc signal is applied to the transistor being tested.

Cathode bias for V202B is provided by resistor R239 is left unbypassed to provide negative feedback and minimize the distortion V202B. The output at the plate of V202B is developed across the primary of output transformer T201 which provides an impedance match for a 10 ohm load. The primary of T201 is tuned to 1-kc by capacitor C227. The output at the secondary of T201 is applied through the FUNCTION switch to the transistor being tested.

An operating potential of regulated 150 volts DC is supplied to V202. Resistor R240 and capacitor C215 form a decoupling network to prevent any 1-kc signal from entering the vacuum tube voltmeter circuit through the common power supply

4.5 TUNED VACUUM TUBE VOLTMETER

The vacuum tube voltmeter is used to provide direct readout of the hybrid parameter being tested.

The input signal to the VTVM circuit is selected by deck 5 on S201 (FUNCTION). The signal selected by S201 is coupled through capacitor C205 to the high side of attentuator R205 and R207 thru R211. In the first five positions of AC RANGE switch S204, a fraction of the total applied 1-kc signal selected by section 5 of S204 is applied to the grid of V203.

When S204 is operated to CAL., the oscillator output is applied to the input of V203 through a 1000-to-1 voltage divider, R204 and R205. Standardized oscillator output is then obtained by adjustment of calibrate control R245 to produce full-scale deflection on meter M201.

The output of V203 resulting from the input signal selected by S201 and S204 is developed across plate load resistor R248 and coupled by attenuating network C221 and R250 to the tuned circuit consisting of inductor L203 and capacitors C220 and C219. The tuned cirucit minimizes the response of the circuit to signals at other than a frequency of 1-kc, thus providing essentially noise-free response.

The output of the filter is coupled by capacitor C222 to the grid of V204A, one section of triode type 12AX7A. The output of this stage is coupled by capacitor C223 to the grid of V204B. The output of V204B is coupled to bridge rectifier D208 through D211. Meter M201 indicates the magnitude of the rectified output from the bridge rectifier and this indication represents the value of the transitor parameter being measured.

Negative feedback voltage, applied from the output of V204B through the bridge rectifier, is developed across resistor R252 to provide gain stabilization of V204A and V204B. Overall gain is such that full scale indication on M201 is obtained with approx. 1 MV pp input to the grid of V203.

4.6 AUXILIARY POWER SUPPLY

Transformer T101 is used to convert 115 VAC line voltage for plate and filament supplies.

Secondary winding 3 thru 5 is connected to D206 and D207 to supply high voltage full wave rectified output.

C208 and R232 form a capacitor input RC filter for the VTVM plate supply. Plate voltage for the 1KC oscillator and VTVM preamplifier is regulated by V201.

Filament voltages are supplied by secondary windings 5 and 6 on T101.

SECTION 5

MAINTENANCE

5.1 INSTRUCTION MANUAL

A Birtcher Instruction Manual usually contains hand made changes to diagrams and parts lists and sometimes texts. These changes are generally appropriate only to the instrument the manual was prepared for. These hand-made corrections show changes to the instrument that have been made after the printing of the manual.

There is a serial number on the warranty page of this manual. This is the serial number of your instrument. Be sure the manual number matches the instrument number when you order parts.

NOTE: Always include the instrument type and serial number in any correspondence regarding the instrument.

5.2 REPLACEMENT PARTS

5.2.1 Standard Components

Birtcher will supply replacement components at current net prices. However, since most of the components are standard electronic and radio parts, you can probably obtain them locally faster than we can ship them to you from the factory in Monterey Park, California. Be sure to consult the parts list to see what tolerances are required.

5.2.2 Selected Components

We specially select some of the components whose values must fall within prescribed limits. By sorting through our regular stocks the components so selected will have standard retma color coding showing the value and tolerance of the stock they were selected from, but they will not in general be replaceable from dealer stock.

5.2.3 Birtcher Manufactured Parts

Birtcher manufactures almost all of the mechanical parts and some of the components used in the instrument. If you order a mechanical part be sure to describe the part completely to prevent any unnecessary delay in filling your order. When you have any questions about mechanical parts or Birtcher manufactured components, contact our nearest field sales representative or write to the service department at the factory in Monterey Park, California.

5.3 REMOVAL AND REPLACEMENT OF PARTS

The procedures required for replacement of most parts in the type 10AC-1 are obvious. Detailed instructions for their removal are not required. Other parts, however, can be best removed if a definite procedure is followed. Instruction for the removal of some of these parts are contained in the following paragraphs.

5.3.1 Replacement of Switches

Methods of removal of defective switches, are, for the most part, obvious and only a normal amount of care is required. Single wafers are normally not replaced on the switches used in the type 10AC-1 and if one wafer is defective, the entire switch should be replaced. Switches may be ordered from Birtcher either wired or unwired as desired.

5.3.2 Replacement of PC Board Components

Some components in the 10AC-1 are mounted on a printed circuit board. To avoid damage to the PC board when replacing components the following precautions should be observed:

1. Use a low power soldering iron (50 watts maximum).

2. Use only a high quality rosin core solder. NEVER A PASTE FLUX. After soldering, clean off any excess flux.

3. When replacing components with multiple mounting pins such as tubes, potentiometers, etc., it will be necessary to lift each pin slightly, working around the components several times until it is free.

5.4 CALIBRATION

5.4.1 Preliminary

The type 10AC-1 test module is a stable instrument and should never require internal adjustment affecting calibration. However, a periodic performance check is desireable from the standpoint of preventative maintenance.

The following equipment is necessary for a complete performance check of the 10AC-1 test module.

1. Precision DC Microampmeter
   0 - 1 MA 1%
   Simpson Model 1702, 1703 or equivalent.

2. Precision DC Voltmeter to cover range from 3 to 30 volts with 1% accuracy.
   Simpson Model 1700 or equivalent.

5.4.1 Preliminary (continued)

3. Precision resistor decade with values from 10 ohms to 1 meg. ½% accuracy.

4. Precision 10 ohm ½% resistor.

Connect the Model 10AC-1 to the Model 70. Install power transistor test adapter. Mechanically zero all meters.

5.4.2 AC Measurements

The accuracy of the AC measurements made with the 10A can be checked by the following procedures employing only passive precision elements.

1. Place front panel controls in the following positions:

TEST	RESET
ADJUST controls	CCW
POLARITY	PNP
EMITTER CURRENT	1 MA
COLLECTOR VOLTAGE	3
AC RANGE	CAL.
FUNCTION	h_{ib}

2. Turn POWER on and allow a 5 minute warm-up.

3. Adjust CAL. control for full scale indication on AC voltmeter.

4. Connect the resistance decade between E and B terminal.

5. Set the resistance decade to 10 ohms.

6. Set the AC RANGE switch to 10 position.

7. Depress the TEST switch.

8. AC meter should indicate full scale ± 3% (indication may be slightly high due to resistance of test leads.)

9. Set AC RANGE switch to 30 Range.

10. AC meter should be at 1/3 full scale position (10 ohms on 30 ohms range).

11. Set AC RANGE switch to 100 range.

12. Increase decade resistance in 10 ohms steps and observe linearity. Maximum error allowable ± 3% of full scale indication.

5.4.2 AC Measurements (continued)

Additional performance check may be made on parameters as follows:

h_{ib} Connection of a precision resistor between the emitter and base terminals of the test set will allow any inaccuracy in h_{ib} measurements to be determined. The value of the resistor can be measured just as the input impedance of a transistor would be. Resistances of 25 to 100 ohms are typical.

h_{rb} A 1000: 1 voltage divider between collector and base, with the tapped point connected to the emitter jack, should give an equivalent h_{rb} reading of .001, or full-scale on the lowest range. A 10K precision resistor (decade box) from "C" to "E" and a similar 10 ohm resistor from "E" to "B" is suggested. Other resistance ratios can be used to simulate other feedback ratios.

h_{ob} Output admittance measurements can be checked in much the same way as those of input impedance, by measurement of a precision resistor connected between collector and base terminals. A typical range of values is from 100K to several megohms. Measurements of a megohm and above will be slightly low because of the shunting effect of stray capacities.

h_{ie} Common emitter input impedance measurements can be checked the same way as h_{ib}. Resistances of 100 ohms to 1K are typical. 100 ohms should give full scale on the lowest range. 1K will give full scale on the lowest range with the X10 (h_{ie}, h_{fe} ONLY) pushbutton depressed.

h_{re} This measurement is similar to h_{rb} except the 1000.1 voltage divider is connected between collector and emitter with the tapped point connected to the base jack. This will give a reading equivalent to h_{re} of .001, or full scale with the AC RANGE switch in the 10 position.

h_{oe} Common emitter output admittance measurements can be checked the same way as h_{ob} except the precision resistor should be connected between the collector and emitter terminals. 100K will give full scale indication with the AC RANGE switch in the 10 position.

5.4.2 AC Measurements (continued)

NOTE: On h_{ib}, h_{rb}, h_{ob}, h_{ie}, h_{re}, and h_{oe} measurements with AC RANGE switch in the 300 and 1000 positions refer to correction graph figure 2-1 page 3

hfe An equivalent base input current gain of unity is obtained by connecting the base and collector terminals with a jumper. Full scale meter indication on the lowest range is 10; therefore, a reading of one-tenth scale should be obtained.

5.4.3 I_E Measurement

1. Place Front Panel controls in the following positions:

TEST	RESET
ADJUST controls	CCW
POLARITY	PNP
EMITTER CURRENT	1 MA
FUNCTION	h_{ib}

2. Connect microammeter (1 or 1.5 MA full scale range) between base (-) and emitter (+) test jacks.

3. Depress TEST switch.

4. Increase I_e ADJUST control (upper, Model 70) for 1 MA indication on external meter. I_e meter should indicate full scale ± 2%.

5.4.4 V_C Measurement

1. Place front panel controls in the following positions:

TEST	RESET
ADJUST controls	CCW
POLARITY	PNP
COLLECTOR VOLTAGE	3V
FUNCTION	h_{ib}

2. Connect voltmeter (3V full scale range) between collector (-) and base (+) test jacks.

3. Depress TEST switch.

4. Increase V_C ADJUST control (lower, Model 70) for 3V indication on external meter. V_C meter should indicate full scale ± 2%.

5.5 FACTORY ADJUSTMENT

For the test set to operate properly, the tuned circuit in the VTVM and the oscillator must be tuned to the same frequency, a moderate amount of adjustment of frequency is provided in the VTVM by trimmer capacitor C219.

Equipment required for this adjustment is a module connector cable Birtcher P/N B5536 and a non-metallic screwdriver.

Connect the 10AC-1 Test Module to the model 70 with the module connector cable. Proceed with the adjustment as follows:

1. Turn on the test set and allow it to warm-up for at least 5 minutes.

2. Operate AC RANGE switch to CAL.

3. Rotate calibrate control (above AC RANGE switch) to the extreme right, then back off slightly.

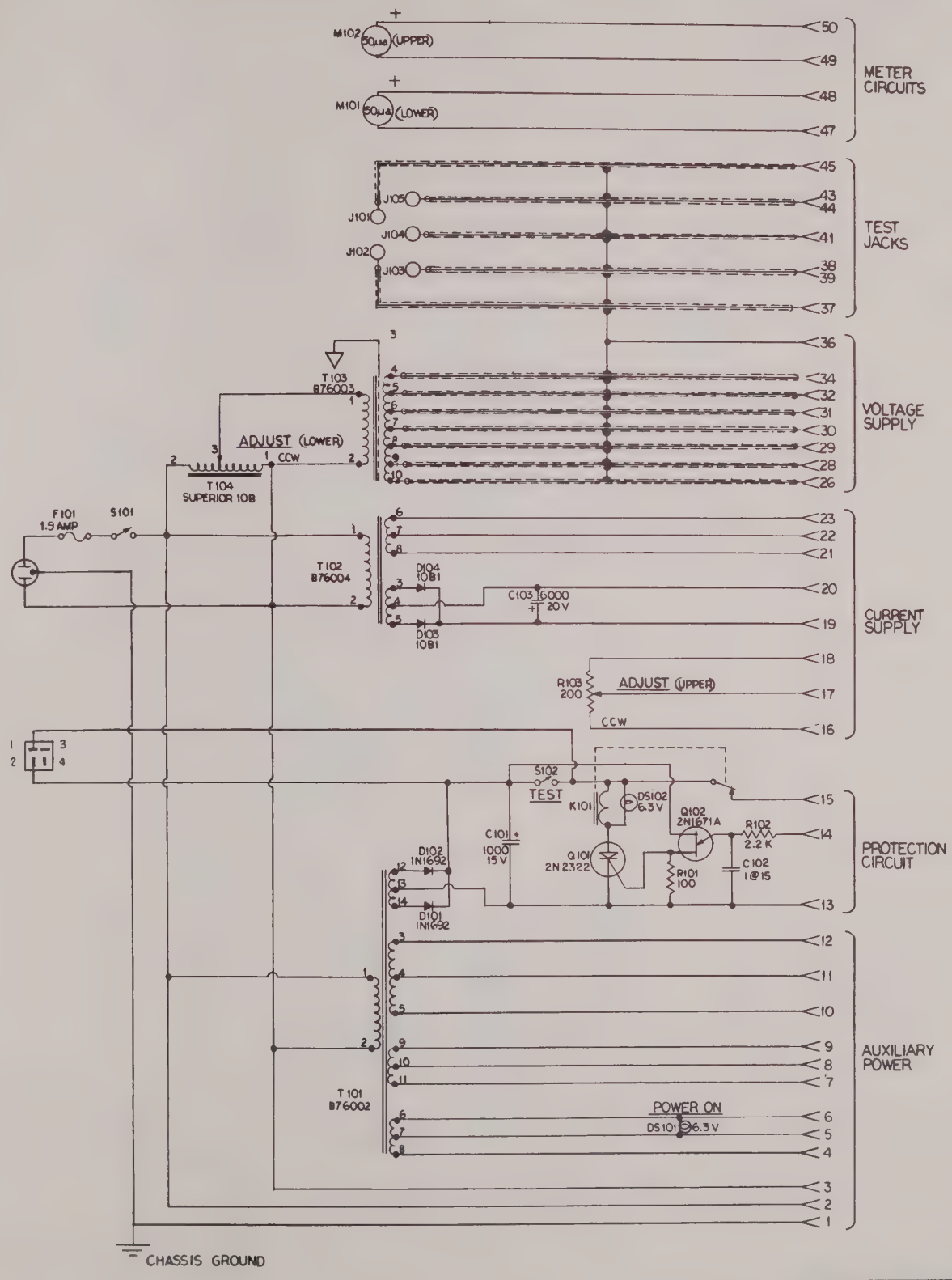
4. Use a non-metallic screwdriver and adjust C219 to obtain a maximum indication on the module meter. If the meter indication tends to go beyond full scale, rotate calibrate control to the left to keep the indication within the limits of full scale. It should be possible to obtain full scale indication with calibrate control less than full to the right.

SECTION 6
PARTS LIST

TRANSFORMER	DESCRIPTION	PART NUMBER
T 201	Output	B76043
CAPACITORS		
C 201	1500 MFD @ 50 VDC Electrolytic	104-011
C 202	1500 MFD @ 50 VDC Electrolytic	104-011
C 203	3 MFD @ 150 VDC Bathtub	103-075
C 204	.002 MFD @ 1000 VDC Disc	100-080
C 205	.05 MFD @ 600 VDC Disc	100-078
C 206	500 MFD @ 25 VDC Electrolytic	104-007
C 207	500 MFD @ 15 VDC Electrolytic	104-006
C 208	40-40 MFD @ 300 VDC Electrolytic	104-100
C 209	330 MMFD @ 500 VDC Mica	101-050
C 210	100 MMFD @ 500 VDC Mica	101-025
C 211	33 MMFD @ 500 VDC Mica	101-000
C 212	40 MFD @ 6 VDC Electrolytic	104-004
C 213	8 MFD @ 150 VDC Electrolytic	104-005
C 214	.05 MFD @ 600 VDC Disc	100-078
C 215	8 MFD @ 150 VDC Electrolytic	104-005
C 216	8 MFD @ 150 VDC Electrolytic	104-005
C 217	40 MFD @ 6 VDC Electrolytic	104-004
C 218	8 MFD @ 150 VDC Electrolytic	104-005
C 219	190-900 MMFD @ 175 VDC Variable Trimmer	105-000
C 220	.002 MFD @ 1000 VDC Disc	100-080
C 221	.005 MFD @ 1000 VDC Disc	100-077
C 222	.1 MFD @ 500 VDC Disc	100-076
C 223	.01 MFD @ 600 VDC Disc	100-075
C 224	.1 MFD @ 500 VDC Disc	100-076
C 225	4 MFD @ 250 VDC Electrolytic	104-008
C 226	40 MFD @ 15 VDC Electrolytic	104-010
C 227	.015 MFD @ 400 VDC Mylar	102-050
C 228	.002 MFD @ 1000 VDC Disc	100-080
C 229	.002 MFD @ 1000 VDC Disc	100-080
C 230	.02 MFD @ 1000 VDC Disc	100-079
C 231	500 MFD @ 15 VDC Electrolytic	104-006
CHOKES		
L 201	.1 Hy	B76158
L 202	5 Hy	B76159
L 203	10 Hy Torroid	B76041
L 204	1 Hy @ 100 MA	B76057

DIODES	DESCRIPTION	PART NUMBER
D 201	SC 1	740-006
D 202	SC 1	740-006
D 203	SC 1	740-006
D 204	SC 1	740-006
D 205	SC 1	740-006
D 206	SC 6	740-002
D 207	SC 6	740-002
D 208	1N118	740-003
D 209	1N118	740-003
D 210	1N118	740-003
D 211	1N118	740-003
METER		
M 201	50 MA F.S. ± 1%	A76001
RELAY		
K 201	DPDT 6 VDC	540-004
RESISTORS		
R 201	100 Ohm, 10 Watt Wirewound	553-075
R 202	10 Ohm, 1% Wirewound	553-025
R 204	10K, 1% Dep. Carb.	551-026
R 205	10 Ohm, 1% Wirewound	553-025
R 206	1K, 1% Dep. Carb.	551-001
R 207	700K, 1% Dep. Carb.	551-088
R 208	245K, 1% Dep. Carb.	551-091
R 209	70K, 1% Dep. Carb.	551-052
R 210	24.5K, 1% Dep. Carb.	551-060
R 211	10.5K, 1% Dep. Carb.	551-061
R 212	597K, 1% Dep. Carb.	551-092
R 213	1.5M	550-179
R 214	57.5K, 1% Dep. Carb.	551-059
R 215	58 Ohm	550-025
R 216	47 Ohm	550-000
R 217	1K, 1 Watt	550-054
R 218	100K	550-127
R 219	33K	550-125
R 220	10K	550-101
R 221	3.3K	550-077
R 222	1K	550-053
R 223	220 Ohm	550-050
R 225	2.5K, 1% Dep. Carb.	551-032
R 226	500 Ohm, 1% Dep. Carb.	551-004
R 227	131 Ohm, 1% Dep. Carb.	551-005
R 228	41.8 Ohm, 1% Wirewound	553-051
R 229	12.6 Ohm, 1% Wirewound	553-052
R 230	4.17 Ohm, 1% Wirewound	553-000

RESISTORS (cont.)	DESCRIPTION	PART NUMBER
R 231	1.25 Ohm, 1% Wirewound	553-001
R 232	180 Ohm	550-027
R 233	3K, 5 Watt, Wirewound	553-125
R 234	180K	550-155
R 235	560K	550-154
R 236	1.8M	550-180
R 237	2.7K	550-076
R 238	220K	550-150
R 239	1.2K	550-075
R 240	1K	550-053
R 241	47K	550-126
R 242	100K	550-127
R 243	198K, 1% Dep. Carb.	551-089
R 244	10 Ohm, 1% Wirewound	553-025
R 245	1M, Variable	554-079
R 246	1K	550-053
R 247	5.6K	550-081
R 248	150K	550-156
R 249	10K	550-101
R 250	470K	550-152
R 251	10M	550-177
R 252	82 Ohm	550-028
R 253	10M	550-177
R 254	1M	550-175
R 255	47K	550-126
R 256	390 Ohm	550-056
R 257	4.7K	550-078
R 258	100 Ohm, 1 Watt, 1% Dep. Carb.	551-000
R 259	10K, 1% Dep. Carb.	551-026
R 260	100K, 1% Dep. Carb.	551-057
R 261	900K, 1% Dep. Carb.	551-078
R 262	12M	550-182
SWITCHES		
S 201	Rotary 5 Pole, 7 Position	A76088
S 202	Rotary 3 Pole, 7 Position (S)	A76086
S 203	Rotary 1 Pole, 3 Position (NS)	A76089
S 204	Rotary 2 Pole, 6 Position (NS)	A76087
S 205	Lever 6 Pole, 2 Position (NS)	870-000
S 206	Push Button SPDT	872-002
S 207	Push Button SPDT	872-002
TRANSISTOR		
Q 201	2N1544 Power PNP.	741-001
TUBES		
V 201	0A2	910-000
V 202	6U8A	910-101
V 203	6AU6	910-100
V 204	12AX7A	910-150



4 RESISTANCES IN OHMS.
3. UNDERLINED CONTROL DESIGNATIONS APPEAR ON FRONT PANEL
2 CAPACITANCES IN μfd.
1. RESISTORS ½W, ±10%, CARBON.

NOTES: UNLESS OTHERWISE SPECIFIED.

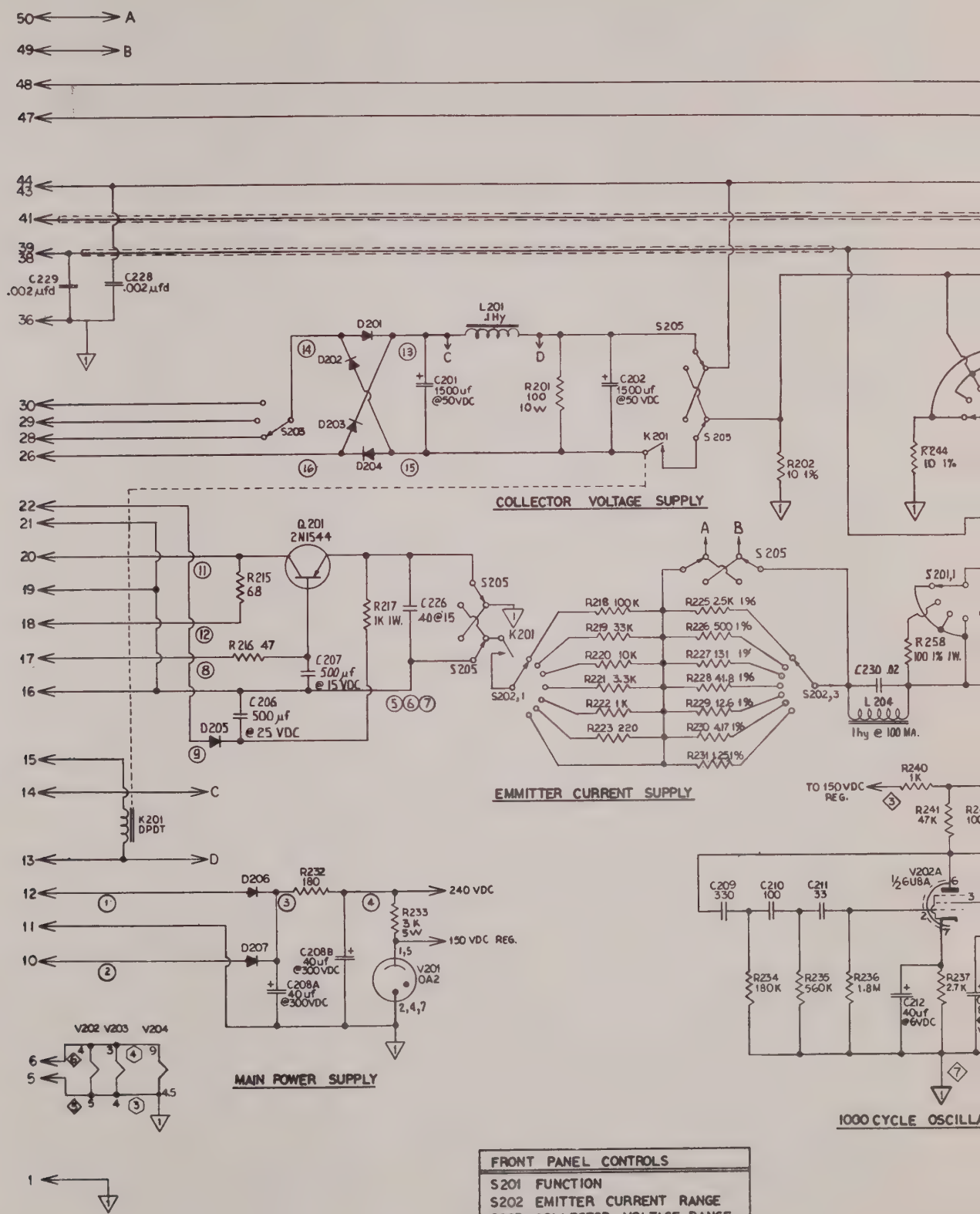
REV.	DESCRIPTION	DATE	DRWN	APPD
D	GROUNDED TERMINAL 3 ON T103	3-1-64	E.B.	RM
C	REMOVED R104, R105 & D105. REV. PROTECT. CIRC., R101 WAS 220Ω R102 WAS 100Ω, C102 WAS 5, Q101 WAS TI 145A0	1-29-63	E.B.	RM
B	ADDED D105 IN118	3-18-63	L.M.	PM
A	Q102 WAS 2N1761, R102 WAS 100K, C102 WAS .25, NOTE #4 ADDED. F101 WAS 1 AMP.	2/22/63	A.V.K.	RM

REVISIONS

BIRTCHER CORP/INDUSTRIAL DIVISION

MODEL 70
SEMICONDUCTOR TEST SET
BASIC UNIT
SCHEMATIC

DRWN: A.V.K. DATE: 6.25.62.
APPD: R.M DATE: 6.26.62
REV. D

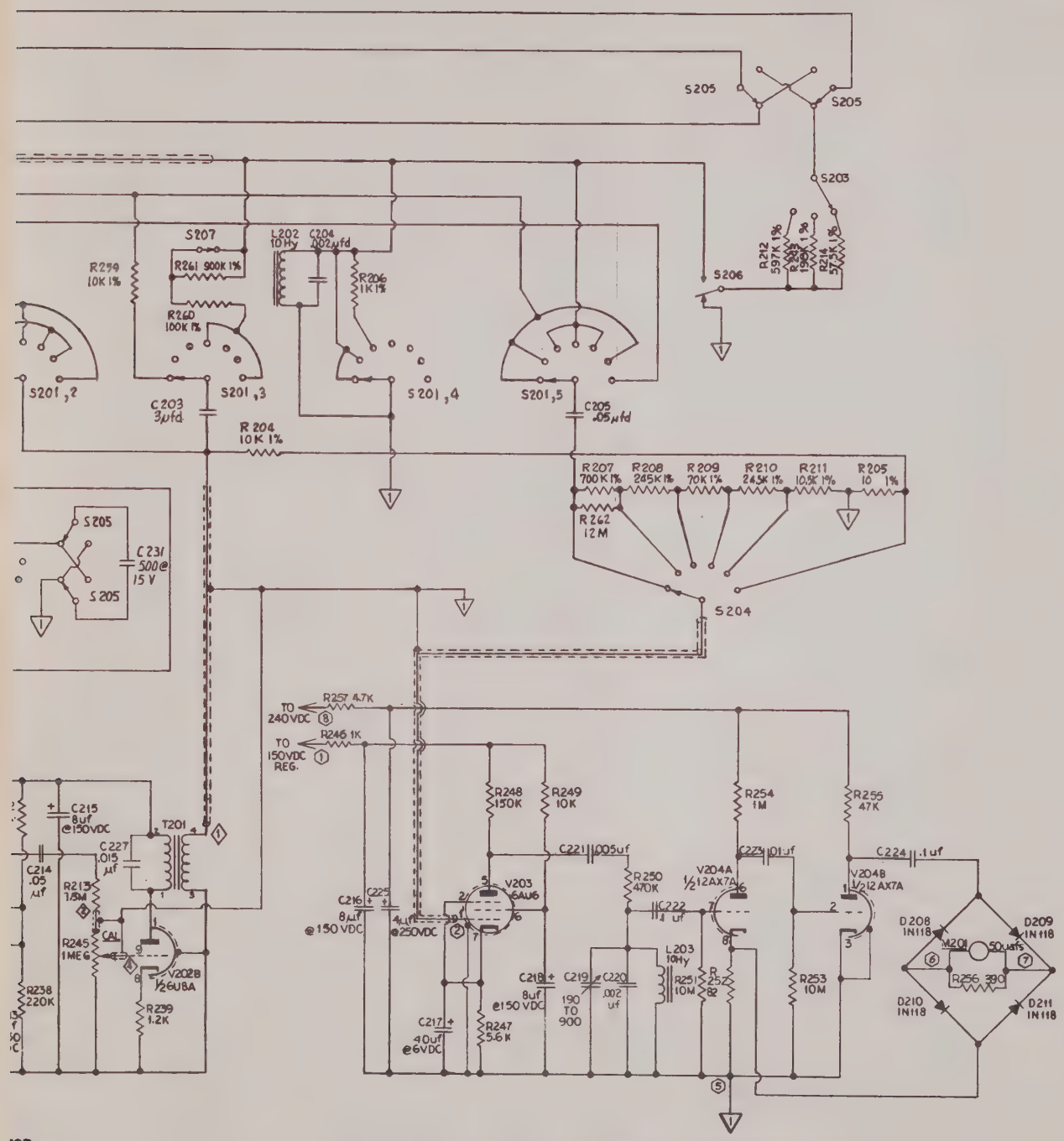


FRONT PANEL CONTROLS	
S201	FUNCTION
S202	EMITTER CURRENT RANGE
S203	COLLECTOR VOLTAGE RANGE
S204	A C RANGE
S205	POLARITY
S206	VOLTAGE - CORRECT
R245	CAL
S207	X 10 (hie AND hfe ONLY)

6. P.C. BOARD NO'S: ◇ OSCILLATOR, ○ VOLTMETER, ○ POWER SUPPLY
5. ALL RESISTANCES IN OHMS.
4. ALL CAPACITORS 200 V.
3. ALL CAPACITANCES IN µµfd.
2. ALL RESISTORS ½W., 10% CARBON.
1. ALL ROTARY SWITCHES SHOWN IN CCW POSITION.

NOTES: UNLESS OTHERWISE SPECIFIED.

REVISION				
REV.	DESCRIPTION	DATE	BY	APP'D
A	EMITTER CURRENT SUPPLY CHANGED	3-27-63	EB	RM
B	C230 WAS C228 : C231 WAS C227 AND R258 WAS R262 AND R228 WAS 41.7	3-24-64	EB.	RM



TUNED A C VOLTMETER

BIRTCHER CORP./INDUSTRIAL DIVISION	
MODEL 10 A C-1	
SCHEMATIC	
DRAWN: A.V.K.	DATE: 8.29.62.
APPR'D.: RM	DATE: 5-13-63

REV. B

WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing parts which prove to be defective during the warranty period. We are not liable for consequential damage.

For assistance of any kind, including help with instruments under warranty, contact your authorized Birtcher sales representative for instructions. Give full details of the difficulty and include the instrument model and serial number. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, except transportation charges. Estimates of charges for non-warranty or other service work will always be supplied if requested before work begins.

Serial Number 10AC-1-_____

OPERATION OF 10 AC

A. GENERAL

Operation of the 10AC is simple and easy to learn. The front panel has been divided into three main blocks. These blocks have been color coded to provide a simple means of remembering the basic operation of the instrument. Black markings refer to emitter current controls and meter. Red markings refer to collector voltage controls and meter. Blue markings refer to hybrid test controls and meter.

B. INITIAL TURN ON AND WARM UP

1. Turn both ADJUST controls fully counter-clockwise.
2. Put POWER switch in on position.
3. After a warm-up period of 1 to 2 minutes, switch AC RANGE switch to the CAL position.
4. Adjust the CAL adjustment for full scale reading on the AC meter.

NOTE: This calibration should be checked periodically while in use.

C. DC BIAS ADJUSTMENT

1. Set POLARITY switch to type of semiconductor to be tested.
2. Set EMITTER CURRENT RANGE switch to desired test range.
3. Set COLLECTOR VOLTAGE RANGE switch to desired test range.
4. Depress TEST switch.
5. Turn LOWER ADJUST control until desired collector voltage is indicated on voltage meter (lower left).
6. Turn UPPER ADJUSTMENT control until desired emitter current is indicated on EMITTER CURRENT meter, (upper left).

NOTE: Voltage is normally read between collector and ground potential; for a true V_{CB} reading, depress the VOLTAGE CORRECT button. DO NOT make hybrid measurement readings with this button depressed.